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(54) **POWER TOOL AND TRANSMISSION SHAFT ASSEMBLY THEREOF**

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F16C 3/02	(2006.01)
F16H 3/64	(2006.01)

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CPC ***A01G 3/053*** (2013.01); ***A01G 3/062*** (2013.01); ***B25F 5/02*** (2013.01); ***F16C 3/02*** (2013.01); *F16H 3/64* (2013.01)

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CPC .. A01G 3/062; A01G 3/053; A01D 2034/907; A01D 34/90; A01D 34/902; A01D 34/905; B25F 3/00; B25F 5/02

USPC 30/276, 296.1

See application file for complete search history.

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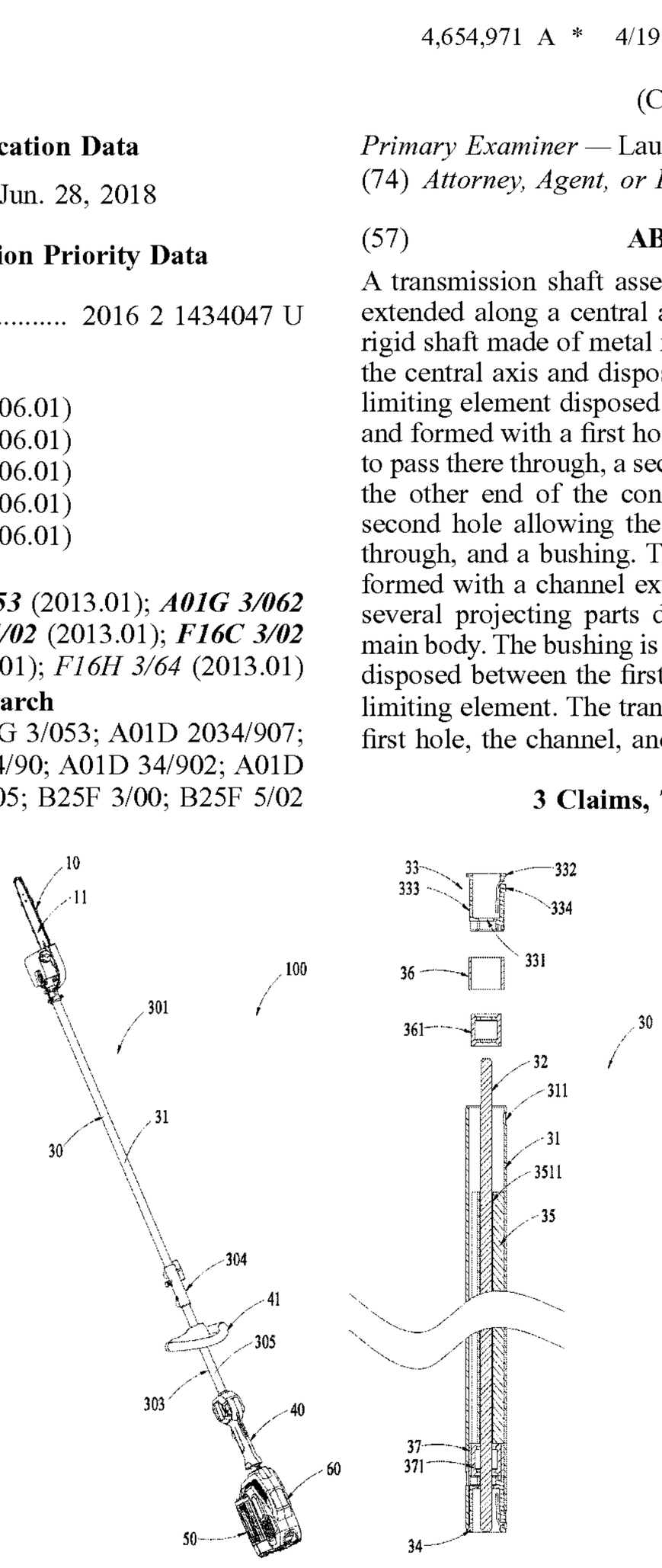
(57) **ABSTRACT**

A transmission shaft assembly includes a connecting tube extended along a central axis, a transmission shaft being a rigid shaft made of metal material, which is extended along the central axis and disposed in the connecting tube, a first limiting element disposed on an end of the connecting tube and formed with a first hole allowing the transmission shaft to pass there through, a second limiting element disposed on the other end of the connecting tube and formed with a second hole allowing the transmission shaft to pass there through, and a bushing. The bushing includes a main body formed with a channel extended along the central axis and several projecting parts disposed on the periphery of the main body. The bushing is located in the connecting tube and disposed between the first limiting element and the second limiting element. The transmission shaft passes through the first hole, the channel, and the second hole successively.

3 Claims, 7 Drawing Sheets



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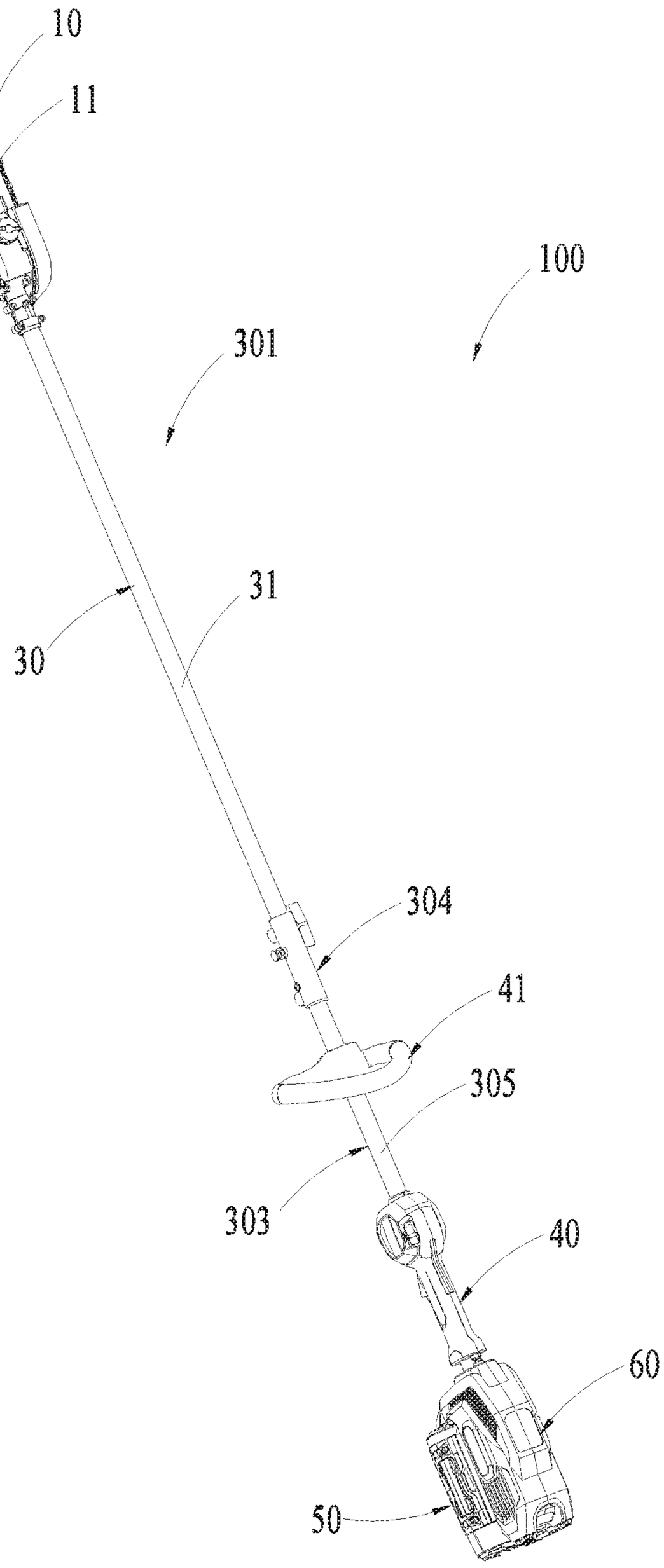

FIG. 1

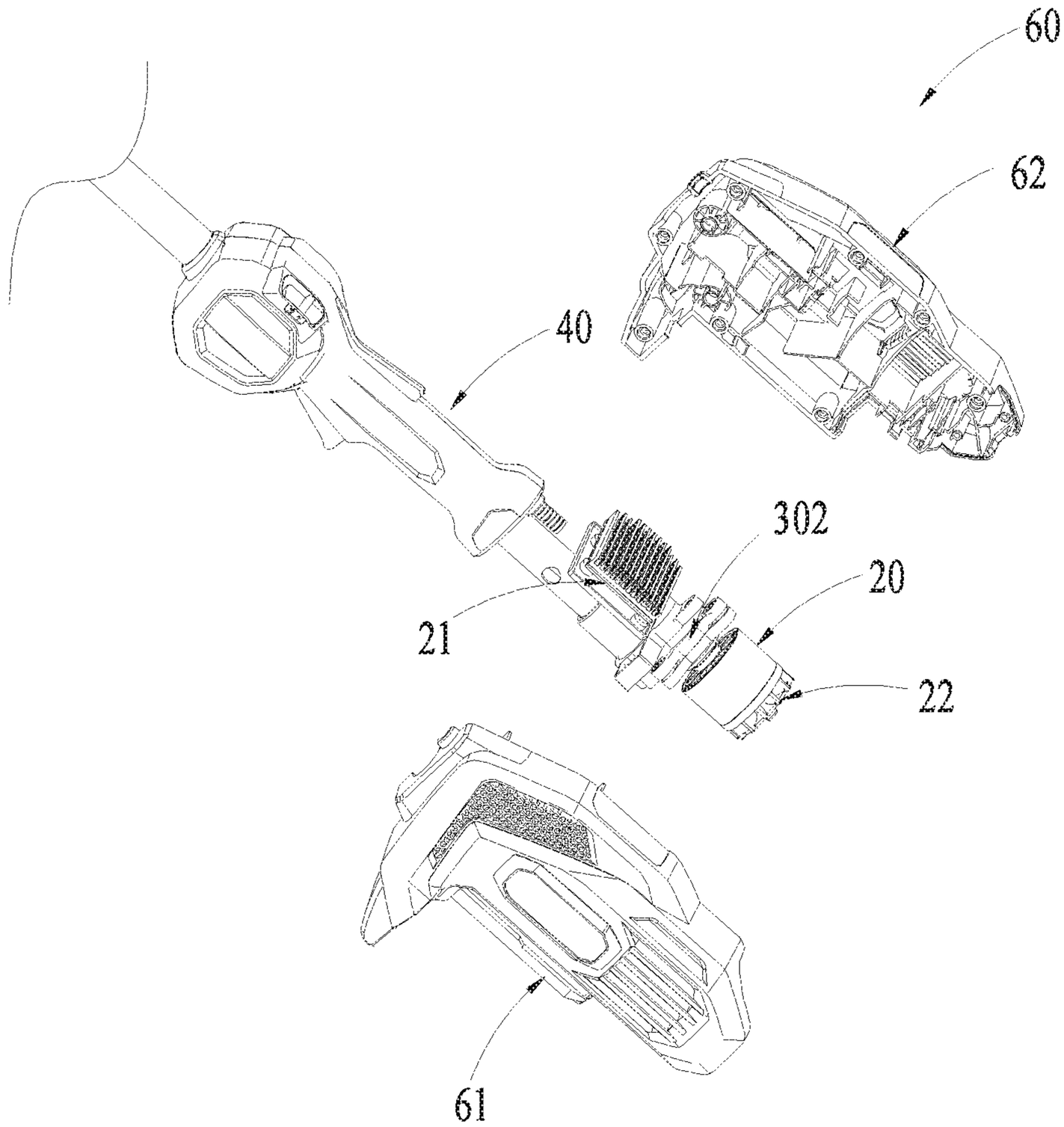

FIG. 2

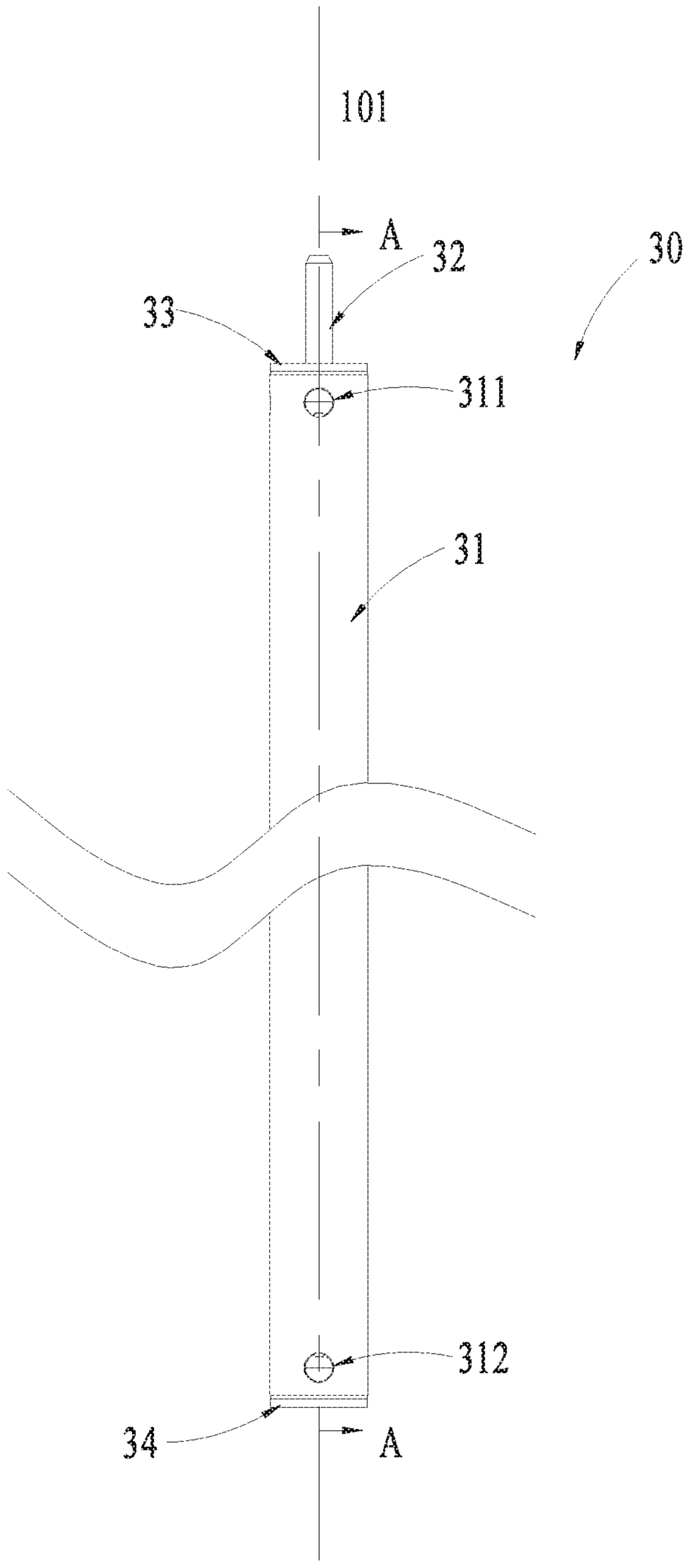

FIG. 3

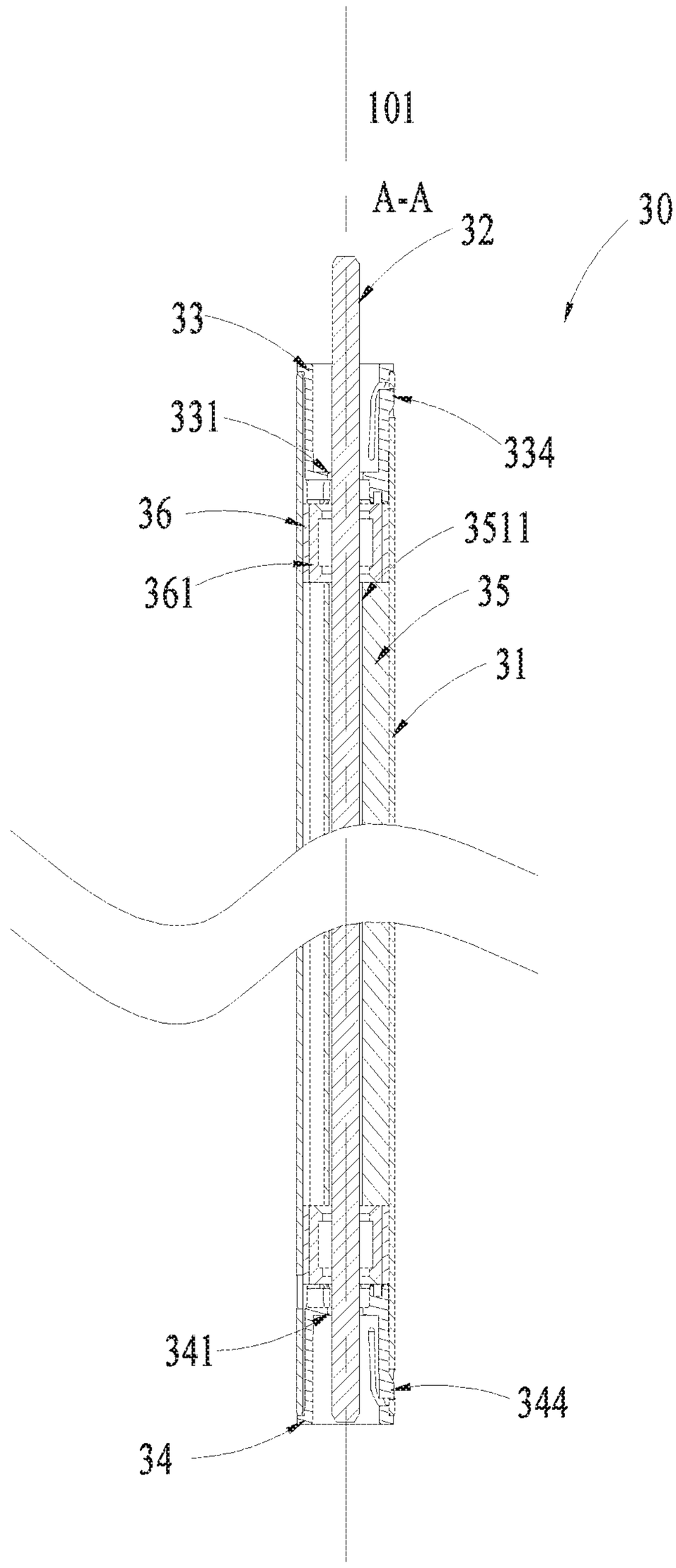

FIG. 4

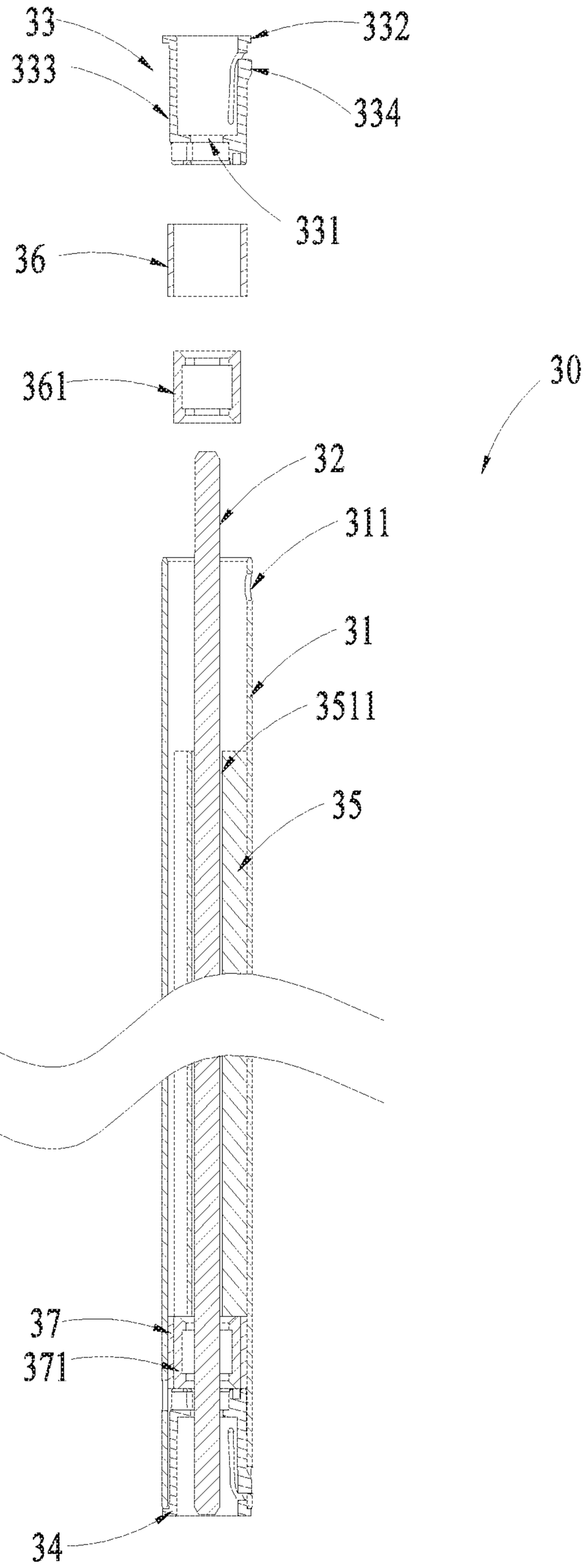

FIG. 5

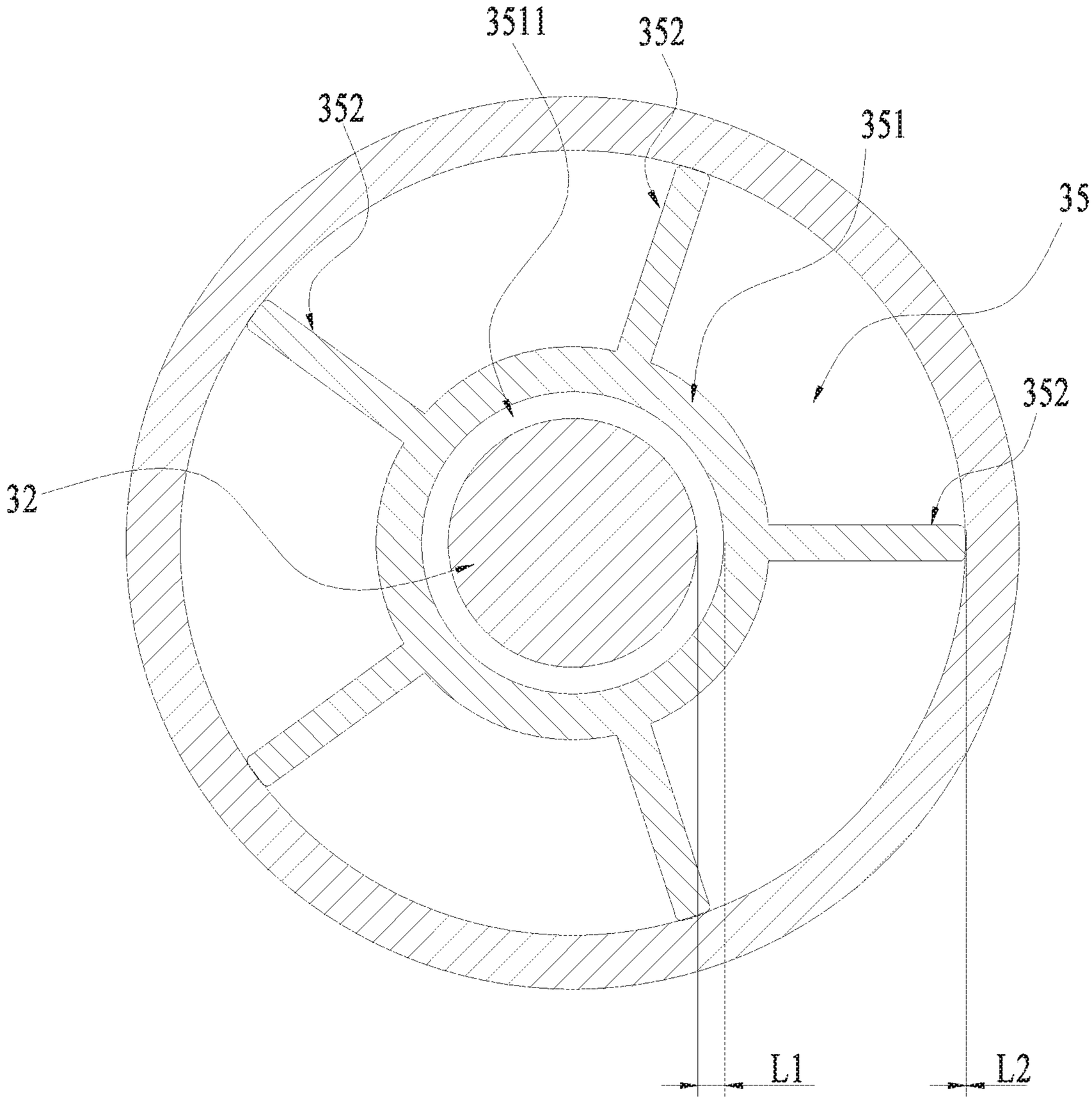

FIG. 6

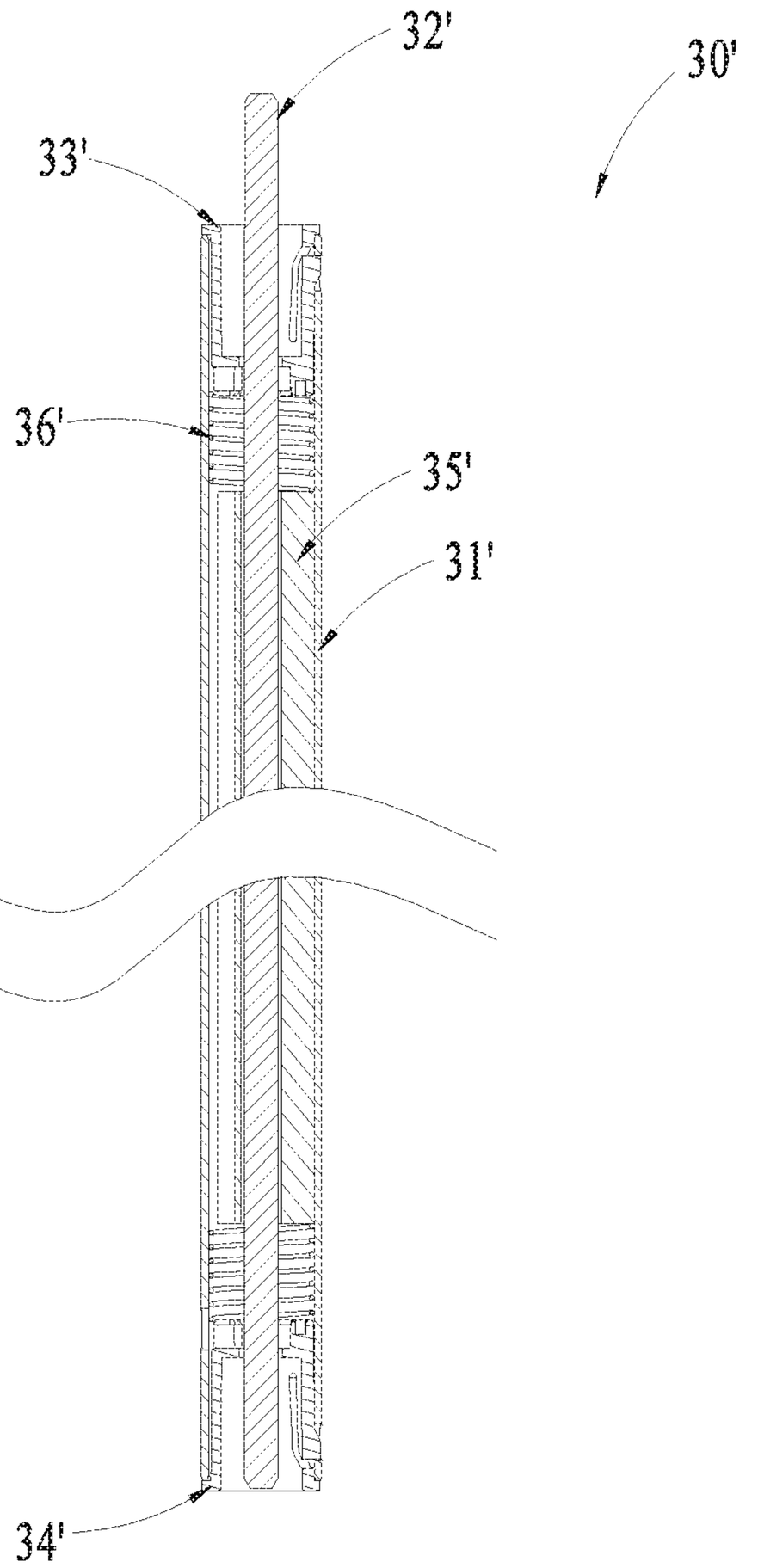

FIG. 7

POWER TOOL AND TRANSMISSION SHAFT ASSEMBLY THEREOF

RELATED APPLICATION INFORMATION

This application claims the benefit under 35 U.S.C. § 119(a) of Chinese Patent Application No. CN 201621434047X, filed on Dec. 23, 2016, the disclosure of which is incorporated herein by reference in its entirety.

FIELD OF THE DISCLOSURE

The present disclosure relates generally to a power tool and a transmission shaft assembly thereof.

BACKGROUND OF THE DISCLOSURE

Pole saws, grass trimmers and hedge trimmers with extension handles belong to long-rod type power tools with a long connecting rod. A motor and a work attachment are disposed on two ends of the connecting rod. A transmission shaft is disposed in the connecting rod.

During operation of currently known long-rod type power tools, it is easy to generate vibration in the connecting rod because of the long transmission shaft.

The statements in this section merely provide background information related to the present disclosure and may not constitute prior art.

SUMMARY

In one aspect of the disclosure, a transmission shaft assembly is provided. The transmission shaft assembly includes a connecting tube extended along a central axis, a transmission shaft being a rigid shaft made of metal material, which is extended along the central axis and disposed in the connecting tube, a first limiting element disposed on an end of the connecting tube and formed with a first hole allowing the transmission shaft to pass there through, a second limiting element disposed on the other end of the connecting tube and formed with a second hole allowing the transmission shaft to pass there through, and a bushing. The bushing includes a main body formed with a channel extended along the central axis and several projecting parts disposed on the periphery of the main body. The bushing is located in the connecting tube and disposed between the first limiting element and the second limiting element. The transmission shaft passes through the first hole, the channel and the second hole successively.

In another aspect of the disclosure, a power tool is provided. The power tool includes a motor, a work attachment driven by the motor to perform the function of the tool, and a transmission device for connecting the motor and the work attachment and transmitting power of the motor to the work attachment. The transmission device includes a transmission shaft assembly. The transmission shaft assembly includes a connecting tube extended along a central axis, a transmission shaft being a rigid shaft made of metal material, which is extended along the central axis and disposed in the connecting tube, a first limiting element disposed on an end of the connecting tube and formed with a first hole allowing the transmission shaft to pass there through, a second limiting element disposed on the other end of the connecting tube and formed with a second hole allowing the transmission shaft to pass there through, and a bushing. The bushing includes a main body formed with a channel extended along the central axis and several projecting parts disposed on the periphery of the main body. The bushing is located in the connecting tube and disposed between the first limiting element and the second limiting element. The transmission shaft passes through the first hole, the channel and the second hole successively.

Further areas of applicability will become apparent from the description provided herein. It should be understood that the description and specific examples are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic view of an exemplary power tool.

FIG. **2** an exploded view of a part of the power tool in FIG. **1**.

FIG. **3** is a plane view of a transmission shaft assembly of the power tool in FIG. **1**.

FIG. **4** is a section view of the transmission shaft assembly along A-A in FIG. **3**.

FIG. **5** is an exploded view of the transmission shaft assembly in FIG. **4**.

FIG. **6** is a section view of a transmission shaft, a bushing and a connecting tube in FIG. **4**.

FIG. **7** is a section view of a further exemplary transmission shaft assembly.

The drawings described herein are for illustrative purposes only of selected embodiments and not all possible implementations, and are not intended to limit the scope of the present disclosure. Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION

The following description of the preferred embodiments is merely exemplary in nature and is in no way intended to limit the scope of the invention hereinafter claimed, its application, or uses.

Referring to FIGS. **1-2**, a power tool **100** includes a work attachment **10**, a motor **20**, a transmission device **301** and a main handle **40**.

The work attachment **10** for performing the function of the tool is driven by the motor **20**. The motor **20** can be an inner combustion engine powered by burning fuel or an electric motor powered by electricity. Specifically, the motor **20** is an electric motor. The power tool **100** further includes a battery pack **50** for supplying power to the motor **20** which is connected with the motor **20** electrically. The power tool **100** is an electric power tool. The transmission device **301** is connected with the motor **20** and the work attachment **10** to transmit the power of the motor **20** to the work attachment **10**. The main handle **40** is for a user to grip, which is disposed between the work attachment **10** and the motor **20**. The power tool **100** also can be called a hand-held power tool **100**. The power tool **100** further includes an auxiliary handle **41** for the user to grip. During operation of the power tool **100**, the user can grip the main handle **40** and the auxiliary handle **41** with two hands respectively.

The power tool **100** includes a housing **60** for mounting the motor **20**. The motor **20** is disposed within the housing **60**. The battery pack **50** is removably connected with the housing **60**. The power tool **100** includes a circuit board **21** for controlling the motor **20** which is disposed within the housing **60**. The power tool **100** further includes a fan **22** for cooling the motor **20** which is driven to rotate by the motor **20**. The fan **22** rotates to provide an airflow that will flow

through the motor **20** and the circuit board **21** so as to cool the motor **20** and the circuit board **21**. The housing **60** includes a left housing **61** and a right housing **62** which cooperatively form a containing chamber for containing the motor **20**.

Specifically, the work attachment in FIG. **1** is a saw chain, and the power tool **100** is a pole saw. The power tool **100** further includes a guide plate **11** for guiding the saw chain to rotate. The guide plate **11** is formed with a guide slot. The saw chain is at least partially located in the guide slot. The power tool **100** is not limited to the pole saw. In other embodiments, the power tool **100** may be a hedge trimmer or a grass trimmer.

Referring to FIGS. **1-2**, the transmission device **301** includes a transmission shaft assembly **30**, a gear box **302**, a second transmission shaft assembly **303** and a connecting base **304**. The gear box **302** is disposed in the housing **60**. The connecting base **304** is used to connect the transmission shaft assembly **30** and the second transmission shaft assembly **303**. The second transmission shaft assembly **303** has the same structure as the transmission shaft assembly **30**. Or, it could be said that the transmission device **301** can include several transmission shaft assemblies **30** which are connected through the connecting bases **304**. Specifically, the transmission shaft assembly **30** includes a connecting tube **31**, and the second transmission shaft assembly **303** includes a second connecting tube **305**. The connecting base **304** connects the connecting tube **31** and the second connecting tube **305**.

Referring to FIGS. **3-5**, the transmission shaft assembly **30** includes the connecting tube **31**, a transmission shaft **32**, a first limiting element **33**, a second limiting element **34** and a bushing **35**.

The transmission shaft **32** is driven by the motor **20** to rotate about a central axis **101**. The connecting tube **31** is extended along the central axis **101**. The transmission shaft **32** is disposed in the connecting tube **31**. The transmission shaft **32** is made of metal material and is a rigid shaft, which cannot bend to any angle. However, a flexible shaft opposite to the rigid shaft can bend, and rotate about a rotation axis so as to transmit torque while it is bent. The rotation axis of the flexible shaft is an arc, and the rotation axis of the rigid shaft is a straight line.

The first limiting element **33** is disposed on one end of the connecting tube **31**, and the second limiting element **34** is disposed on the other end of the connecting tube **31**. The bushing **35** is located in the connecting tube **31**. The first limiting element **33** and the second limiting element **34** limit the bushing **35** in the connecting tube **31** to prevent the bushing **35** from disengaging from the connecting tube **31**. The bushing **35** is able to rotate relative to the connecting tube **31**. Specifically, the bushing **35** is able to rotate relative to the connecting tube **31** about the central axis **101**. The first limiting element **33** is formed with a first hole **331** allowing the transmission shaft **32** to pass there through, and the second limiting element **34** is formed with a second hole **341** allowing the transmission shaft **32** to pass there through.

Referring to FIGS. **4-6**, the bushing **35** includes a main body **351** and several projecting parts **352**. The main body **351** is formed with a channel **3511** extended along the central axis **101**. The several projecting parts **352** are disposed on the periphery of the main body **351**. The transmission shaft **32** passes through the first hole **331**, the channel **3511** and the second hole **341** successively. The projecting parts **352** are extended along the central axis **101**. The main body **351** has a length in a direction of the central axis **101** which is equal to the length of the projecting parts **352** in the direction of the central axis **101**.

A distance L**1** from the outer wall of the transmission shaft to the inner wall of the channel **3511** is greater than a distance L**2** from the projecting parts **352** to the inner wall of the connecting tube **31**. The inner wall of the channel **3511** has a maximum size in a radial direction of the central axis **101** which is greater than the maximum size of the transmission shaft **32** in the radial direction of the central axis **101**.

In a section perpendicular to the central axis **101**, the several projecting parts **352** are disposed on the periphery of the main body **351** and distributed uniformly about the central axis **101**. In the section perpendicular to the central axis **101**, the channel **3511** formed by the main body **351** has a circular section, and the transmission shaft **32** has a circular section as well. In this section, the maximum size of the channel **3511** in the radial direction of the central axis **101** is a diameter of the channel **3511**, and the maximum size of the transmission shaft **32** in the radial direction of the central axis **101** is a diameter of transmission shaft **32**. The diameter of the channel **3511** is greater than the diameter of transmission shaft **32**. The distance L**1** from the outer wall of the transmission shaft **32** to the inner wall of the channel **3511** is ½ a difference between the maximum size of the channel **3511** and the maximum size of the transmission shaft **32** in the radial direction of the central axis **101**. As a specific embodiment, the projecting parts **352** contact with the inner wall of the connecting tube **31**, that is the distance from the projecting parts **352** to the inner wall of the connecting tube **31** is substantially equal to 0.

If the length of the transmission shaft **32** in the direction of the central axis **101** is too long, vibration may occur. A gap is disposed between the outer wall of the transmission shaft **32** and the inner wall of the channel **3511** and the transmission shaft **32** can be rotated freely relative to the bushing **35**, so the slight vibration of the transmission shaft **32** that may occur in the channel **3511** is avoided from transmitting to the connecting tube **31** directly and transmitting to the main handle **40** finally. While, when the transmission shaft **32** produces greater vibration in the channel **3511**, it strikes the inner wall of the channel **3511**, and the torque of the transmission shaft **32** is transmitted to the bushing **35** and the bushing **35** is driven by the transmission shaft **32** to rotate, so the vibration is further reduced.

Referring to FIGS. **3-5**, the first limiting element **33** and the second limiting element **34** are made of plastic material. The first limiting element **33** includes a first limiting portion **333** and a first contacting portion **332**. The first limiting portion **333** is extended in the connecting tube **31**, and the first contacting portion **332** contacts with an end of the connecting tube **31**. The first contacting portion **332** has a size in the radial direction of the central axis **101** which is greater than the size of the first limiting portion **333** in the radial direction of the central axis **101**. The first contacting portion **332** limits the first limiting element **33** to move toward a direction along the central axis **101** relative to the connecting tube **31**.

The connecting tube **31** is formed with a first limiting hole **311** on its wall. The first limiting element **33** is formed with a first projection **334** for engaging with the first limiting hole **311**. The first projection **334** is located in the first limiting hole **311**. The engagement of the first projection **334** and the first limiting hole **311** limits the first limiting element **33** to move toward another direction along the central axis **101** relative to the connecting tube **31**. The engagement of the

first projection **334** and the first limiting hole **311** avoids the first limiting element **33** from disengaging with the connecting tube **31**.

The connecting tube **31** is formed with a second limiting hole **312**. The second limiting element **34** is formed with a second projection **344** for engaging with the second limiting hole **312**. The second projection **344** is located in the second limiting hole **312**. The engagement of the second projection **344** and the second limiting hole **312** limits the position of the second limiting element **34** relative to the connecting tube **31**. Specifically, the second limiting element **34** can have the same structure as the first limiting element **33**.

The transmission shaft assembly **30** further includes a first biasing element **36** disposed between the bushing **35** and the first limiting element **33**. The first biasing element **36** applies a biasing force between the bushing **35** and the first limiting element **33**, or it could be said that the first biasing element **36** applies a biasing force on the bushing **35** to limit the position of the bushing **35** relative to the connecting tube **31**. Specifically, the first biasing element **36** applies a biasing force along the central axis **101** on the bushing **35**. The first biasing element **36** has two ends which contact with the bushing **35** and the first limiting element **33** respectively. Specifically, the first biasing element **36** is a rubber element. The transmission shaft assembly **30** further includes a first bearing **361**. Specifically, the first bearing **361** is an oil bearing. The first bearing **361** is sleeve-connected on the outside of the transmission shaft **32**. The rubber element is sleeve-connected on the outside of the first bearing **361**. The first bearing **361** supports the rubber element. The first biasing element **36** limits the position of the bushing **35** in the direction of the central axis **101** relative to the connecting tube **31**, so that the vibration in this direction is reduced.

The transmission shaft assembly **30** further includes a second biasing element **37** disposed between the bushing **35** and the second limiting element **34**. The bushing **35** is disposed between the first biasing element **36** and the second biasing element **37**. The second biasing element **37** is a rubber element, which is sleeve-connected on the outside of a second bearing **37**.

As shown in FIG. **7**, in another example, a transmission shaft assembly **30'** includes a connecting tube **31'**, a transmission shaft **32'**, a first limiting element **33'**, a second limiting element **34'**, a bushing **35'** and a first biasing element **36'**.

The first biasing element **36'** is a spring, which is disposed between the bushing **35'** and the first limiting element **33'**. Comparing with the transmission shaft assembly **30** in FIG. **4**, the transmission shaft assembly **30'** in FIG. **7** uses the spring as the first biasing element **36'**, and the bearings are omitted.

The above illustrates and describes basic principles, main features and advantages of the subject device. Those skilled in the art should appreciate that the above embodiments do not limit the invention hereinafter claimed in any form. Technical solutions obtained by equivalent substitution or equivalent variations are all intended fall within the scope of the claimed invention.

What is claimed is:

1. A power tool, comprising:

a motor;

a work attachment driven by the motor to perform a function of the power tool; and

a transmission device for connecting the motor and the work attachment to transmit power of the motor to the work attachment;

wherein the transmission device comprises a transmission shaft assembly, the transmission shaft assembly comprising:

a connecting tube extended along a central axis;

a transmission shaft, comprising a rigid shaft, which extends along the central axis and which is disposed in the connecting tube;

a first limiting element disposed on an end of the connecting tube and formed with a first hole allowing the transmission shaft to pass there through;

a second limiting element disposed on the other end of the connecting tube and formed with a second hole allowing the transmission shaft to pass there through;

a bushing comprising a main body formed with a channel extended along the central axis and several projecting parts disposed on the periphery of the main body;

a first biasing element applying a force on the bushing along the central axis; and

a first bearing that is sleeve-connected on the outside of the transmission shaft,

wherein the bushing is located in the connecting tube and disposed between the first limiting element and the second limiting element such that the transmission shaft passes through the first hole, the channel, and the second hole successively, and

wherein the first biasing element and the first bearing are disposed between the bushing and the first limiting element and the first biasing element is a rubber element that is sleeve-connected on the outside of the first bearing.

2. The power tool of claim **1**, wherein a distance from an outer wall of the transmission shaft to an inner wall of the channel is greater than a distance from the projecting parts to an inner wall of the connecting tube.

3. The power tool of claim **1**, wherein the power tool is a pole saw and, the work attachment is a saw chain.

* * * * *